CLAIMS

1. An apparatus for heating, reforming, or cracking hydrocarbon fluids or other fluids in a process having a process heat requirement for heating a process fluid in the process, comprising:

an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second interior regions being substantially symmetrical about said first longitudinal axis;

at least one elongated reaction chamber having a design temperature and a second longitudinal axis substantially parallel to said first longitudinal axis, said reaction chamber being substantially symmetrical about said second longitudinal axis, a first portion of said reaction chamber being disposed in said first interior region of said shell and a second portion of said reaction chamber being disposed in said second interior region of said shell, said first and second portions of said reaction chamber adapted to contain a flow of said process fluid;

a plurality of burners adjacent said inner wall, each of said burners adapted to combust at least one fuel, thereby producing a flue gas in said first interior region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of said reaction chamber while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature; and

transfer means adjacent the second end of said shell, whereby at least a portion of a flow of said flue gas flows from the first interior region of said shell to the second interior region of said shell.

2. An apparatus as in claim 1, wherein at least a portion of said process fluid flows through at least the first or second portion of said reaction chamber counter-currently with at least a portion of said flow of said flue gas.

3. An apparatus as in claim 1, wherein a substantial portion of said reaction chamber is substantially vertical within said shell.

4. An apparatus as in claim 1, wherein said shell is substantially cylindrical.

5. An apparatus as in claim 1, wherein said shell has a cross-sectional area substantially in the form of an ellipse.

6. An apparatus as in claim 1, wherein said shell has a cross-sectional area substantially in the form of a polygon.

7. An apparatus as in claim 1, wherein a flame is radially directed from said burner substantially toward said first longitudinal axis of said shell.

8. An apparatus as in claim 1, further comprising at least one refractory wall disposed in said shell adjacent said burner, said refractory wall being substantially perpendicular to said inner wall.

9. An apparatus for heating, reforming, or cracking hydrocarbon fluids or other fluids in a process having a process heat requirement for heating a process fluid in the process, comprising:

an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second interior regions being substantially symmetrical about said first longitudinal axis;

at least one elongated reformer tube having a design temperature and a second longitudinal axis substantially parallel to said first longitudinal axis, said reformer tube being substantially symmetrical about said second longitudinal axis, a first portion of said reformer tube being disposed in said first interior region of said shell and a second portion of said reformer tube being disposed in said second interior region of said shell, said first and second portions of said reformer tube adapted to contain a flow of said process fluid;

a plurality of burners adjacent said inner wall, each of said burners adapted to combust at least one fuel, thereby producing a flue gas in said first interior region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of said reformer tube while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature; and

transfer means adjacent the second end of said shell, whereby at least a portion of a flow of said flue gas flows from the first interior region of said shell to the second interior region of said shell.

10. An apparatus for heating, reforming, or cracking hydrocarbon fluids or other fluids, comprising:

an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second interior regions being substantially symmetrical about said first longitudinal axis;

at least one elongated reaction chamber having a second longitudinal axis substantially parallel to said first longitudinal axis, said reaction chamber being substantially symmetrical about said second longitudinal axis, a first portion of said reaction chamber being disposed in said first interior region of said shell and a second portion of said reaction chamber being disposed in said second interior region of said shell;

a plurality of elongated burner assemblies adjacent said inner wall, each of said burner assemblies having a different longitudinal axis substantially parallel to said first and second longitudinal axes, a first end, and a second end opposite said first end, the first end of said burner assembly being adjacent the first end of said shell and the second end of said burner assembly being in said first region of said shell, said burner assemblies being substantially equally spaced apart peripherally around said inner wall and at least two neighboring burner assemblies being

substantially equidistant from said reaction chamber, each said burner assembly adapted to combust at least one fuel, thereby generating a flue gas in said first interior region of said shell; and

transfer means adjacent the second end of said shell whereby at least a portion of a flow of said flue gas flows from the first interior region of said shell to the second interior region of said shell.

11. An apparatus as in claim 10, wherein said reaction chamber is a reformer tube.

12. An apparatus for heating, reforming, or cracking hydrocarbon fluids or other fluids in a process having a process heat requirement for heating a process fluid in the process, comprising:

an elongated shell having an inner wall, a first longitudinal axis, a cross-sectional area, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second interior regions being substantially symmetrical about said first longitudinal axis;

a plurality of rays of one or more elongated reaction chambers, each ray being substantially perpendicular to said inner wall, said rays dividing said cross-sectional area into a plurality of equally-sized sectors having substantially identical shapes, each of said reaction chambers having a design temperature and a different longitudinal axis substantially parallel to said first longitudinal axis, and being substantially symmetrical

about said different longitudinal axis, a first portion of each said reaction chamber being disposed in said first interior region of said shell and a second portion of each said reaction chamber being disposed in said second interior region of said shell, said first and second portions of said reaction chamber adapted to contain a flow of said process fluid;

a plurality of burners adjacent said inner wall, at least one burner being disposed in each said sector and each of said burners adapted to combust at least one fuel, thereby producing a flue gas in said first interior region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of each reaction chamber while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature; and

transfer means adjacent the second end of said shell, whereby at least a portion of a flow of said flue gas flows from the first interior region of said shell to the second interior region of said shell.

13. A method for producing a product from a process for heating, reforming, or cracking hydrocarbon fluids or other fluids, the process having a process heat requirement for heating a process fluid, comprising the steps of:

providing an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second

interior regions being substantially symmetrical about said first longitudinal axis;

providing at least one elongated reaction chamber having a design temperature and a second longitudinal axis substantially parallel to said first longitudinal axis, said reaction chamber being substantially symmetrical about said second longitudinal axis, a first portion of said reaction chamber being disposed in said first interior region of said shell and a second portion of said reaction chamber being disposed in said second interior region of said shell, said first and second portions of said reaction chamber adapted to contain a flow of said process fluid;

providing a plurality of burners adjacent said inner wall, each of said burners adapted to combust at least one fuel;

combusting said at least one fuel in at least one of said burners, thereby producing a flue gas in said first region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of said reaction chamber while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature;

transferring at least a portion of a flow of said flue gas from said first interior region of said shell to said second interior region of said shell; and

feeding at least a portion of said process fluid to said reaction chamber, wherein said portion of said process fluid absorbs at least a portion of said heat flux.

14. A method as in claim 13, comprising the further step of withdrawing a stream of the product from said reaction chamber.

15. A method as in claim 13, wherein at least a portion of said process fluid flows through at least the first or second portion of said reaction chamber counter-currently with at least a portion of said flow of said flue gas.

16. A method as in claim 13, wherein a flame is radially directed from said burner substantially toward said first longitudinal axis of said shell.

17. A method for producing a product from a process for heating, reforming, or cracking hydrocarbon fluids or other fluids, the process having a process heat requirement for heating a process fluid, comprising the steps of:

providing an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and having a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second regions being substantially symmetrical about said first longitudinal axis;

providing at least one elongated reformer tube having a design temperature and a second longitudinal axis substantially parallel to said first longitudinal axis, said reformer tube being substantially symmetrical about said second longitudinal axis, a first portion of said reformer tube being disposed in said first interior region of said shell and a second portion of said reformer tube being disposed in said second interior region

of said shell, said first and second portions of said reformer tube adapted to contain a flow of said process fluid;

providing a plurality of burners adjacent said inner wall, each of said burners adapted to combust at least one fuel;

combusting at least one fuel in at least one of said burners, thereby producing a flue gas in said first region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of said reformer tube while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature;

transferring at least a portion of a flow of said flue gas from said first interior region of said shell to said second interior region of said shell; and

feeding at least a portion of said process fluid to said reformer tube, wherein said portion of said process fluid absorbs at least a portion of said heat flux.

18. A method for producing a product from a process for heating, reforming, or cracking hydrocarbon fluids or other fluids, comprising the steps of:

providing an elongated shell having an inner wall, a first longitudinal axis, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second

interior regions being substantially symmetrical about said first longitudinal axis;

providing at least one elongated reaction chamber having a second longitudinal axis substantially parallel to said first longitudinal axis, said reaction chamber being substantially symmetrical about said second longitudinal axis, a first portion of said reaction chamber being disposed in said first interior region of said shell and a second portion of said reaction chamber being disposed in said second interior region of said shell;

providing a plurality of elongated burner assemblies adjacent said inner wall, each of said burner assemblies having a different longitudinal axis substantially parallel to said first and second longitudinal axes, a first end, and a second end opposite said first end, the first end of said burner assembly being adjacent the first end of said shell and the second end of said burner assembly being in said first region of said shell, said burner assemblies being substantially equally spaced apart peripherally around said inner wall and at least two neighboring burner assemblies being substantially equidistant from said reaction chamber, said burner assemblies adapted to combust at least one fuel;

combusting said at least one fuel in at least one of said burner assemblies, thereby producing a combustion heat and a flue gas in said first interior region of said shell;

transferring at least a portion of a flow of said flue gas from said first interior region of said shell to said second interior region of said shell; and

feeding at least a portion of a process fluid to said reaction chamber, wherein said portion of said process fluid absorbs at least a portion of said combustion heat.

19. A method as in claim 18, wherein said reaction chamber is a reformer tube.

20. A method for producing a product from a process for heating, reforming, or cracking hydrocarbon fluids or other fluids, the process having a process heat requirement for heating a process fluid, comprising the steps of:

providing an elongated shell having an inner wall, a first longitudinal axis, a cross-sectional area, a first end, and a second end opposite said first end, said shell being substantially symmetrical about said first longitudinal axis and enclosing a first interior region adjacent the first end and a second interior region adjacent the second end, each of said first and second interior regions being substantially symmetrical about said first longitudinal axis;

providing a plurality of rays of one or more elongated reaction chambers, each ray being substantially perpendicular to said inner wall, said rays dividing said cross-sectional area into a plurality of equally-sized sectors having substantially identical shapes, each of said reaction chambers having a design temperature and a different longitudinal axis substantially parallel to said first longitudinal axis, and being substantially symmetrical about said different longitudinal axis, a first portion of each said reaction chamber being disposed in said first interior region of said shell and a second portion of each said reaction chamber being disposed

in said second interior region of said shell, said first and second portions of said reaction chamber adapted to contain a flow of said process fluid;

providing a plurality of burners adjacent said inner wall, at least one burner being disposed in each said sector and each of said burners adapted to combust at least one fuel;

combusting said at least one fuel in at least one of said burners, thereby producing a flue gas in said first interior region of said shell and a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat flux to substantially all of said first portion of said reaction chamber while maintaining substantially all of said first portion substantially at said design temperature without substantially exceeding said design temperature;

transferring at least a portion of a flow of said flue gas from said first interior region of said shell to said second interior region of said shell; and

feeding at least a portion of said process fluid to said reaction chamber, wherein said portion of said process fluid absorbs at least a portion of said heat flux.

21. A variable heat flux side-fired burner system for use in a process for heating, reforming, or cracking hydrocarbon fluids or other fluids, the process having a process heat requirement for heating a process fluid in at least one reaction chamber having a design temperature, a first portion, and a second portion, comprising:

a plurality of adjacent burner units adapted to combust at least one fuel, thereby producing a variable heat flux substantially approximating said process heat requirement and simultaneously maximizing said heat

flux to substantially all of said first portion of said reaction chamber while maintaining substantially all of said first portion substantially at said design temperature without exceeding said design temperature of said reaction chamber.

22. A variable heat flux side-fired burner system as in claim 21, further comprising:

a common fuel supply;

a common air supply;

means for regulating a flow of fuel to each burner unit from said common fuel supply; and

means for regulating a flow of air to each burner unit from said common air supply.

23. A variable heat flux side-fired burner system as in claim 21, wherein said adjacent burner units are equally spaced apart and each burner unit combusts said at least one fuel at a different firing rate.

24. A variable heat flux side-fired burner system as in claim 21, wherein said adjacent burner units are variably spaced apart and each burner unit combusts said at least one fuel at a substantially identical firing rate.

25. A variable heat flux side-fired burner system as in claim 21, wherein said adjacent burner units are variably spaced apart and each burner unit combusts said at least one fuel at a different firing rate.

26. A variable heat flux side-fired burner system as in claim 21, wherein at least one burner unit combusts at least one first fuel or a fuel mixture containing said first fuel t least one other burner unit combusts at least one second fuel or a fuel mixture containing said second fuel.

5

N:\DOCNOS\06000-06099\06068\US\APPLN\06068 usa.doc